Novel Highly Efficient Compact Rotary-Hammering Planetary Sampler Actuated by a Single Piezoelectric Actuator

Completed Technology Project (2011 - 2012)

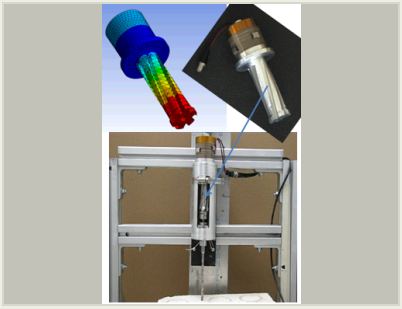
Project Introduction

A wireless drive mechanism using elastic waves transmitted through walls without perforation has been established and thus revolutionized activation of spacecraft systems. The concept consists of a novel acoustic-electrical and acoustic-mechanical feed-through mechanism that eliminates the need for structure perforation and related cabling. Configurations were produced based on the developed analytical capability using finite element modeling and harmonic analysis and were tested experimentally.

We had two objectives in this task: 1. Develop effective single low-mass, low-power piezoelectric drive that can actuate rotary-hammer samplers through walls. 2. Determine design sensitivities and investigate Acoustic Mechanical Feed-throughs (AMF) using acoustic mode conversion with emphasis on extension to rotary. In our earlier studies, we were able to excite rotation from longitudinal vibrations but, without sufficient analytical foundations, it has been a challenge to get consistent results. Therefore, we focused our efforts on the modeling, analysis and optimization of configurations that effectively convert longitudinal forces to torque and rotation. The task consisted of conceiving drive configurations and optimizing them thru finite element and harmonic analysis, as well as producing and demonstrating the physical mechanism. The analytical task provided tools and data to select highly efficient mechanisms that use piezoelectric materials to generate elastic waves that wirelessly transmit power through a metallic wall. We produced a resonant breadboard system that converts high frequency micron-size displacements to macroscopic rotary and linear motions. The developed mechanism uses the converse piezoelectric effect as a means of generating elastic waves, which is transmitted in the form of elastic waves, was used to excite rotation through a wall and establish a basis for a systematic capability to design wireless actuation, manipulation, and deployment thru walls. Efforts were made to optimize the location of the nodal plane of the transducer and difficulties were encountered since the nodal location of the transducer is not necessarily a plane. Through our analytical studies, we were able to produce Acoustic Mechanical Feed-throughs (AMF) capability that consistently and efficiently induces rotation. We established sufficient data and analysis to allow submittal of a credible proposal for further development of the concept.

Anticipated Benefits

The developed mechanism addresses requirements of multiple technical areas of the NASA Space Technology Roadmap including Space Power and Energy Storage; Robotics, Tele-Robotics and Autonomous Systems; Communication and Navigation; Science Instruments, Observatories and Sensor Systems; as well as the Materials, Structures, Mechanical Systems and Manufacturing. Resulting from this task has been a wireless driving mechanism for devices and instruments through integrity critical structures.



Project Image Novel Highly Efficient Compact Rotary-Hammering Planetary Sampler Actuated by a Single Piezoelectric Actuator

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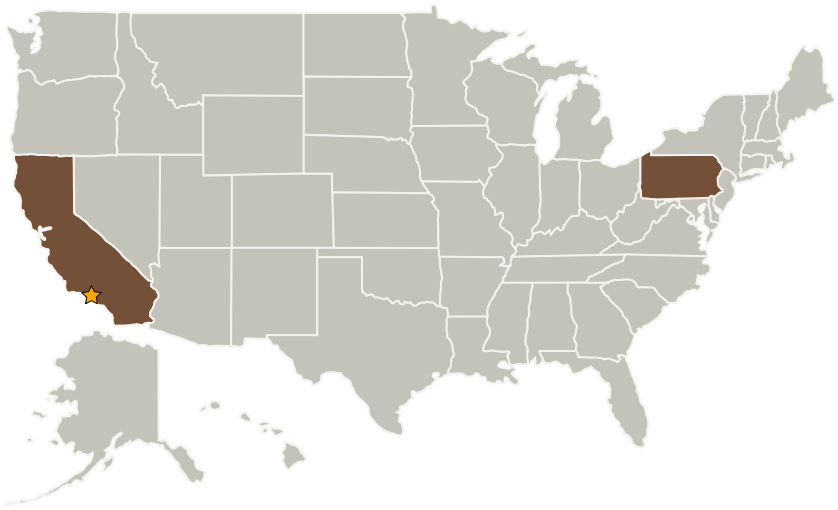
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Co-Funding Partners	Type	Location
Pennsylvania State University-Main Campus(Penn State)	Academia	University Park, Pennsylvania

Primary U.S. Work Locations	
California	Pennsylvania

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Center Innovation Fund: JPL CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

Fred Y Hadaegh

Project Manager:

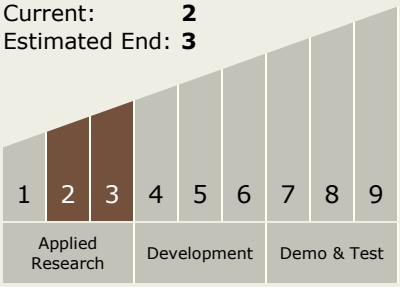
Jonas Zmuidzinas

Principal Investigator:

Yoseph Bar-cohen

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



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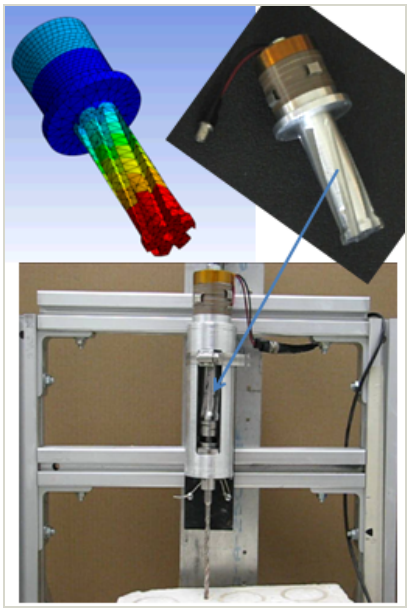
Images



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Project Image Novel Highly Efficient Compact Rotary-Hammering Planetary Sampler Actuated by a Single Piezoelectric Actuator
(https://techport.nasa.gov/image/1157)

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  - TX12.3 Mechanical Systems
    - TX12.3.6 Mechanical Drive Systems